Chapter 18. Phonetic attrition

Esther de Leeuw

Queen Mary University of London

Abstract

Phonetic attrition, i.e. changes in native speech upon acquisition of a second language or dialect post adolescence, reflects malleability of the native language system, with potential trickle down effects initially evidenced in phonological attrition. Examining a range of studies into segmental and prosodic attrition, this chapter discusses phonetic attrition as it occurs in native speech and reflects on interpersonal differences, as well as different developmental processes that underlie phonetic attrition.

***END OF ABSTRACT

18.1. Introduction

Anecdotally, it is not uncommon for people to know friends or family members who moved abroad, and return home with speech differently accented in comparison to before their departure. Or, perhaps, one has experienced such changes in pronunciation oneself. Indeed, there is consistency among the research discussed in this chapter that the native phonetic domain is malleable upon competition from a new language or dialect in adulthood, although the extent of such effects differs between individuals (Bergmann, Nota, Sprenger, & Schmid, 2016; de Leeuw, 2009, 2014, de Leeuw, Mennen, & Scobbie, 2012, 2013; de Leeuw, Schmid, & Mennen, 2010; de Leeuw, Tusha, Zhao, Helke, & Greenfield, forthcoming; Evans & Iverson, 2007; Flege, 1987; Hopp & Schmid, 2013; Major, 1992; Mayr, Price, & Mennen,

2012; Mennen, 2004; Munro, Derwing, & Flege, 1999; Shockey, 1984; Ulbrich & Ordin, 2014).

Research into phonetic attrition (here, attrition is used solely with reference to the L1) is important because native language phones are the building blocks from which all other language representations are built (i.e. in L1 acquisition, children must firstly perceive sounds without an underlying category, before distinctive phonemes are acquired, words built, and sentences constructed (e.g. Maye, Werker, & Gerken, 2002; Polka & Werker, 1994; Stager & Werker, 1997; Werker & Lalonde, 1988). Phonetic attrition is therefore indicative of an unbalancing of the native language system, with potential trickle down effects evidenced in phonological attrition, see chapter on Phonological Attrition by Celata. Moreover, findings suggest that with training the effects of a new competing linguistic system on the native language phonetic system can occur rapidly (Chang, 2012), and that short-term modifications to the phonetic system occur dependent upon the ambient linguistic system (Sancier & Fowler, 1997), see chapter on Phonetic Drift by Chang.

For these reasons, research into phonetic attrition is of great consequence to our understanding of the plasticity of native speech, how languages and dialects interact and are represented in the mind across the lifespan, as well as to how individuals who possess multiple languages and dialects are perceived by other native speakers.

18.2. Definition of attrition

Research into phonetic attrition usually aims to describe changes in pronunciation that occur within an individual's L1 when an L2 is acquired in adulthood, as well as to explain why such changes occur. Within the context of bilingualism, attrition is most often investigated within the scope of long-term immigration (Schmid & Köpke, 2007). In this chapter, the characterisation of attrition is broadened to include studies that have examined pronunciation

changes in the native language upon acquisition of a new dialect in adulthood. The inclusion of dialects into the definition of attrition is relevant when one considers that the terms language and dialect represent a continuum and that their 'edges are extremely ragged and uncertain' (Haugen, 1966, p. 922).

Attrition is not the only way in which an individual's native speech can change post-adolescence. Dialects themselves change over time, which affects the individual's speech production (Harrington, 2006; Harrington, Palethorpe, & Watson, 2000a, 2000b) and, as previously mentioned, short-term rapid changes to the L1 phonetic system have also been reported upon L2 training and exposure (Chang, 2012; Sancier & Fowler, 1997). However, studies into phonetic attrition are considered to reveal long-term changes in the native language pronunciation of an individual as a result of the acquisition of a new dialect or language acquired post-adolescence. Emerging longitudinal research may reveal how such long-term phonetic changes in the form of attrition are affected, or perhaps governed, by such short-term changes, or whether there is a cut-off between the two at all. Together, research that reports phonetic attrition, as described in this chapter, combined with changes to the L1 phonetic system due to the aforementioned factors, lend support to the understanding that there is an inherent degree of plasticity to the native phonetic system both during childhood (Pallier et al., 2003; Ventureyra, Pallier, & Yoo, 2004), as well as post-adolescence, as it develops and adapts throughout the lifespan (see e.g. de Leeuw, Opitz, & Lubinska, 2013).

18.3. Aim of contribution

This contribution aims to summarise research into phonetic attrition by examining the question of whether the pronunciation of a linguistic system learned in childhood and adolescence can change in adulthood, potentially, in an extreme case, even becoming 'foreign accented' (de Leeuw et al., 2010; Hopp & Schmid, 2013), i.e., being perceived by native

speaker listeners to be non-native speech. In doing so, firstly, the term *phonetics* will be defined as applied in this chapter, and thereby differentiated from phonology (see chapter by Celata on Phonological Attrition). Thereafter, the Speech Learning Model (SLM) and its relevance for studies examining phonetic attrition will be discussed, with a view towards assimilation and dissimilation: both processes can occur in phonetic attrition. Subsequently, findings from research into both segmental and suprasegmental phonetic attrition will be summarised, as related to both bilingualism and monolingualism. Research which has examined native speech which is globally regionally or foreign accented will be discussed thereafter. Questions of psycholinguistic, sociolinguistic, and formal relevance are as follows.

1. Why do some individuals appear to undergo more phonetic attrition than others?
2. What can the processes of assimilation and dissimilation tell us about the nature of changes to the phonetic system?
3. Is there a difference between phonetic attrition in a bilingual versus bidialectal context?

18.4. What is phonetics?

Phonetics can be defined as the study of the *realisation* of sounds in spoken language. For example, in the word *love*, phoneticians might examine the actual realisation of the lateral sound at the beginning of *love*, i.e. [l]. Notably, the phonetician might investigate possible variability in the production of the lateral sound, e.g. whether it was realised with a higher pitch in the case of a child, or a lower pitch in the case of an adult. Indeed, there are infinite ways in which individual lateral phones, [l], and indeed all sounds, can be realised. In contrast, phonology can be defined as the study of the *organisation* of the sounds in spoken language. In the example of the word *love*, a phonologist might be interested in the fact that the lateral phoneme can be replaced by /d/ and that the new word arising is *dove*. One way of

conceptualizing phones and phonemes is through a snowflake metaphor. Phones are like individual snowflakes: each one is different; phonemes are like the general category of snowflake in our mind. Although each individual snowflake is different, we are nonetheless able to perceive all snowflakes to belong to the category of snowflake; and we have a separate category for snowflake than we do for hailstone, than we do for raindrop—the infinite variability is constrained.

In terms of attrition, the difference between phonetics and phonology is crucial. Studies which reveal phonetic attrition (de Leeuw, 2014; de Leeuw, Mennen, & Scobbie, 2012, 2013; de Leeuw et al., 2010; de Leeuw et al., forthcoming; Evans & Iverson, 2007; Flege, 1987; Hopp & Schmid, 2013; Major, 1992; Mayr et al., 2012; Mennen, 2004; Munro et al., 1999; Shockey, 1984; Ulbrich & Ordin, 2014) indicate changes with regard to how speakers of a particular language *realise* particular phones in their native language. In contrast, studies which reveal phonological attrition, of which there are far fewer (see e.g. de Leeuw, Tusha, & Schmid, 2017; Dmitrieva, Jongman, & Sereno, 2010), reveal representational changes to the phonemic organisation of the native language. Socially, both phonetic and phonological changes to the native language or dialect may vastly influence how an individual is perceived by others, and indeed potentially their own self-perception.

18.5. Speech Learning Model

Although most widely applied in studies of L2 acquisition, the Speech Learning Model (SLM) was identified early on as relevant to studies into phonetic attrition (see de Leeuw, 2009), as, in addition to predicting how the L1 will influence the L2, the SLM makes claims about how the acquisition of an L2 impacts the L1. Crucial for phonetic attrition, the SLM posits that 'the phonic elements making up the L1 sound system and the phonic elements

comprising the L2 system (either newly established categories, or adaptations of L1 categories) exist in a 'common phonological space', and so will mutually influence one another' (Flege, 2007, p. 366), either through the process of assimilation or dissimilation (Flege, 2007). With regard to phonetic category assimilation, the SLM posits that assimilation will occur when 'the L2 learner continues indefinitely to judge the instances of an L2 category to be instances of an L1 category' (Flege, 2007, p. 359). Alternatively, category dissimilation occurs because 'bilinguals strive to maintain phonetic contrast between all of the elements in their L1 / L2 phonetic space, just as monolinguals strive to maintain phonetic contrast among the elements making up their L1 phonetic space' (Flege, Schirru, & MacKay, 2003, p. 470). However, factors that would explain whether two sounds from the given L1 and L2 undergo assimilation or dissimilation are not given. Moreover, the SLM explicitly constrains itself to segmental elements of speech, rather than prosody, which may also undergo attrition, and is hence also discussed in this chapter. Nevertheless, the bidirectional application of the SLM is extremely relevant to research into phonetic attrition and its simplicity provides a fruitful foundation for studies.

18.6. Segmental assimilation in phonetic attrition

Evidence of assimilation in phonetic attrition has been revealed in both segmental and prosodic analyses (note again that although the SLM does not directly make predictions with regard to prosody, assimilation of prosodic categories will be discussed hereafter).

For example, although the term 'attrition' was never used, a seminal study by Flege (1987) showed that in native American-English speakers immersed in a French environment as adults, and in native French speakers immersed in an American-English environment as adults, voice onset time (VOT) of /t/ productions in English and French were 'merged'

(Flege, 1987, p. 51), becoming intermediate to the target language norms (longer VOT values in English than French). Additionally, within the same study it was found that native French speakers, 'for whom English was clearly their principal language' (p. 52), produced French /u/ with a mean frequency of the second formant (F2) that was higher (1333 Hz) than the value obtained for French monolingual subjects (1196 Hz), approximating English monolingual values (p. 58). Although the results from the vowel analysis were not significant, they suggested that the prolonged acquisition and use of an L2 phonetic system affected the L1 phonetic segments. With regard to the contrast between phonetics and phonology, note that this does not constitute the loss of a phonemic contrast in the L1 categories, but rather a change in the production of the phonetic realisation. Interpersonal variation was not specifically examined in this study; however, the standard deviation of the VOT in the French L1 speakers in Chicago, in their French, overlapped with the French monolinguals' standard deviation of VOT. Similarly, the standard deviation of the English L1 speakers in Paris, in their English, approached the standard deviation of the English monolinguals. Such interpersonal variation suggests that not all subjects evidenced assimilation effects in their /t/ and /u/ productions; others may have undergone less segmental attrition or, alternatively, they may have displayed dissimilation effects.

Another study (Flege & Hillenbrand, 1984) investigated a similar group of French native speakers, who had all learned English as adults and were living in an English-speaking environment for an average of just over 12 years. These late sequential bilinguals were all married to native English speakers and, similarly, the VOT of their /t/ in both French and English was examined. Here too, the averaged results of the subjects indicated that in general the VOT of /t/ in their French was substantially longer (and more English-like) than that of monolingual French speakers (Flege & Hillenbrand, 1984). Moreover, in the same study it was reported that 'the bilingual French native speakers produced French /u/ with a

substantially higher mean F2 value (1387 Hz) than previously reported for monolingual French speakers (987 Hz)' (p. 717), i.e. long-term exposure to English influenced their production of French /u/, causing it to be more English-like, just as it influenced their production of French /t/. The focus of this investigation was again on group differences, rather than on inter- or intrapersonal differences within the speakers who comprised the groups, with the take-away finding that phonetic attrition at the segmental level is exhibited through assimilation effects in sequential bilinguals resident in a prolonged L2 environment.

Building on these group analyses, an influential study of five native American-English speakers who had acquired Brazilian-Portuguese in adulthood, examined such inter- and intra-subject variation. Major (1992) was the first to explicitly use the term 'attrition' in a phonetic context. Even though the subjects in this study reported personal and professional reasons to maintain English in Brazil, all sequential bilinguals, who had been living in Brazil for between 12 and 35 years, exhibited some degree of phonetic attrition in their L1 realisation of VOT (it became shorter and therefore more Portuguese-like, i.e. assimilation effects). In general, there was also a correlation between proficiency in the L2, measured according to the realisation of Portuguese-like VOT, and rate of attrition in English. On average, the lower the VOT (less native-like) in the English casual speech of the subjects, the lower the Portuguese VOT (more native-like). However, this correlation was not displayed in formal English speech (elicited through word and sentence lists, whereas casual speech was taken from informal spontaneous conversations). Moreover, one subject performed outside of the monolingual norms in both English and Portuguese, whilst another performed within the monolingual norms of both languages, at least in formal speech. Therefore, it is possible to summarise that sociolinguistic factors, i.e. degree of formality, also contributed to the extent of phonetic attrition in this segmental analysis, suggesting that although phonetic attrition of segments may be inevitable in a prolonged L2 environment, more naturalistic forms of

speech elicitation may be more likely to promote phonetic attrition, i.e. if speech is elicited formally, the effects of phonetic attrition might not be evidenced at all.

To a certain extent, these studies within a bilingual context built on an early impressionistic study of monolingual phonetic attrition (Shockey, 1984). In this study, four American English speaking residents of the United Kingdom, who had been living in England for between 8–27 years, were examined. This study, within a context of dialect acquisition, involved counting the number of flaps in American speech production, where in Standard Southern British English (SSBE) one would expect a voiced or voiceless alveolar plosive, i.e. /t/ or /d/ in words like, respectively, *latter* and *ladder*. Shockey found differences between subjects, with some individuals exhibiting a greater degree of attrition of segments, and in different phonetic contexts. The voiceless alveolar plosive /t/ was much less likely to flap if it was in a relatively slow phrase, or if it had a high information content; and 'both /t/ and /d/ showed a strong tendency to flap in fast, unstressed, highly redundant speech, with the tendency being much stronger for /d/ than for /t/' (pp. 91–92). Although never drawing on the term 'attrition' specifically, Shockey interpreted that the changes in the American English speech were the result of a 'slow, ongoing process which is not completed for a number of years' (p. 90). In line with Major (1992), her findings suggest that not only amount of exposure to the new linguistic system might account for inter-speaker differences in phonetic attrition, but that speech style also affects intrapersonal variation, with careful speech and high information content eliciting less phonetic attrition.

Aside from these early studies into segmental assimilation effects in plosives, formant frequencies in laterals, rhotics, and vowels have also revealed assimilation effects. For example, within the context of dialect acquisition in monolinguals, a more recent study (Evans & Iverson, 2007) investigated changes in vowel production among university students from Ashby de la Zouch, Leicestershire, UK, a small town in the Midlands where the local

accent is classified as a variety of northern English (Evans, 2005; Wells, 1982). This study enhanced the Shockey (1984) research because it involved both an acoustic analysis, as well as a regional accent rating by fellow British English speakers. Moreover, the subjects in this study had only been resident in their new environment for three years as they had moved to London to study, where they were exposed to SSBE more frequently than in their home town. In the group analysis, the results showed that their accents became more like SSBE, again revealing plasticity in the L1 phonetic system through assimilation effects. Regarding the acoustic formant analysis, the subjects changed their production of *bud*, *cud*, and *could* so that they produced them with a more fronted (higher F2 frequency) and lower (higher F1 frequency) vowel after only two years at university, closer to how southerners produce the vowel in words like *bud* and *cud*. However, there were differences in the amount and direction of accent change: although the majority of subjects were rated as sounding more 'southern' after two years than when they were first recorded; in a minority, there was only a very slight change in accent; three subjects were rated not to have changed their accent at all; and one subject was judged to have a more 'northern' accent at the final testing session than when she first moved to London. This study indicates not only a high degree of interpersonal variation, but also that the process of phonetic attrition, here in a monolingual context, can occur relatively quickly, and that it therefore might not be a slow process, as suggested by Shockey (1984). Moreover, although only revealed in one subject, it also hints at dissimilation effects, to be discussed subsequently.

Formant frequencies have been the subject of further research into phonetic attrition within the context of bilingualism (de Leeuw, Mennen, & Scobbie, 2013; de Leeuw et al., in press; Ulbrich & Ordin, 2014). An investigation into coda lateral production in the German speech of ten German-English late bilinguals who had been living in Vancouver, Canada for between 18 and 55 years, indicated that the F1 frequency of the lateral phoneme in German

words like *viel* and *Kiel* was significantly higher in the German of both the female and male bilinguals than in a respective German control group, becoming more English-like, and therefore indicating segmental attrition through assimilation effects. For the males, F2 frequency was also significantly lower in the German of the bilinguals than in the German monolinguals, as is characteristic of the 'darker' North American English lateral, again, revealing phonetic attrition. Moreover, some of the F1 frequencies were characteristic of the dark values, whilst the F2 values were characteristic of the light values, suggesting a truly assimilated production of the lateral. Interpersonal variation across subjects was also revealed: one male subject (FS) produced the German lateral completely within the English monolingual norm whilst two female subjects produced the German lateral entirely within the German monolingual norm. In line with the previously discussed studies, it was again revealed that phonetic attrition in the form of assimilation effects is an outcome of late bilingualism, although the degree of plasticity of the phonetic L1 system varies across individuals.

The results from this study prompted further investigation into one individual, FS, who stood out, and revealed 'extreme' phonetic attrition in his speech (de Leeuw et al., *forthcoming*). Subject FS was selected for this case study because he displayed phonetic attrition in all of the group phonetic analyses he underwent, whilst the others nine bilinguals who had moved from Germany to Canada did so as well, but less consistently. In addition to the lateral analysis (de Leeuw, Mennen, & Scobbie, 2013), in which it was found that his realisation of German /l/ in coda position was realised entirely within the 'dark' English norm, in a prosodic analysis it was revealed that his realisation of the prenuclear rise in his native German was significantly earlier than is characteristic of German; instead, falling within the English monolingual norm (de Leeuw et al., 2012), to be discussed shortly. Moreover, FS was salient because he was consistently rated to be a non-native speaker of his

native German by German monolinguals in Germany in a global foreign accent rating (de Leeuw et al., 2010), as will also be discussed.

The particular case study investigated phonetic attrition in the rhotic realisations of FS, whose biographical data indicated that, out of all the participants, he was among one of those who had been with their partner the longest, who was a native English speaker and with whom he only spoke English. They had two adult daughters and three grandchildren, with whom he only spoke English, and he had moved to Canada when he was 21, and thereafter had lived in Canada for 53 years. Crucially, when he spoke English, which he did almost always, he did so with next to no code-mixing into German, as none of his English interlocutors spoke German. He therefore differed from the other late bilinguals, who, in one way or another, were all considered to use German more than FS. The impressionistic analysis of his rhotic production revealed that 43% of his German rhotic productions were perceived to be English-like, much higher than that of any other participants (ranging from 0% to 17%). The average F3 frequency of his German rhotic (1790 Hz) approximated values typically given for American-English, such as 1546 Hz (Dalston, 1975), and the range of between 1300 and 1950 Hz for English rhotics (Thomas, 2010), and substantially differed from values typically given for Standard German of between 2500 and 3000 Hz (Ladefoged & Maddieson, 2007). Although all participants in this study into rhotic realisation revealed some degree of phonetic attrition, FS did so more extremely than any of the other participants, and realised the English retroflex rhotic in his German. The authors tentatively suggest that, essentially, complete immersion within an entirely English language setting is what made FS unique, and triggered his extreme attrition, in the domain of phonetics. As such, the findings shed new light on the SLM in that his German rhotic was not merged *intermediately* between German and English monolingual norms, but rather, in this extreme

case of phonetic attrition, his rhotic production assimilated entirely into the monolingual norm of the English retroflex.

Another related study examining formant frequencies in rhotics reported findings from an analysis into vocalisation and rhotic realisation of post-vocalic /r/ in the German native speech of sequential bilinguals who had acquired either a rhotic variety of English as an L2 (Belfast English), or a non-rhotic variety of English (Oxford English) (Ulbrich & Ordin, 2014). In Belfast, the earliest age of arrival was 18 years of age, whilst the oldest age of arrival was 37; in Oxford, the earliest age of arrival was 20 years of age, whilst the oldest age of arrival was 31. The results of the auditory and acoustic analysis of post-vocalic /r/ in the speakers' German and English suggested that attrition occurred in the form of transfer from the L2, i.e. the German native speakers in Belfast and Oxford produced acoustic correlates of rhoticity in their native German speech. However, as noted by the authors, those exposed to Oxford English would not be expected to produce post-vocalic /r/, yet the German native speakers in Oxford *did* produce the acoustic correlates of rhoticity in their German, just like those with Belfast English as their ambient language. The authors therefore suggest that direct transfer from the L2 to the L1 could not have been the sole factor determining phonetic attrition. Instead, they suggest that between-subject variation should take into account 'actual creative language use and communicative events' (p. 26). What particularly stood out in this study is that dialectal variation in an L2 did not necessarily modulate the effects of attrition, and that, although sequential bilinguals may be exposed to a particular variety, other factors, *dissimilating* from the target L2 group in L1 speech, potentially towards a perceived more standard-like variety, e.g. American English, may also play a role.

In line with these studies, a case study examining the speech of a monozygotic twins compared two sisters through an investigation into numerous phonetic variables (Mayr et al., 2012). MZ had moved from the Netherlands to the United Kingdom in early adulthood and

where she had been living for 30 years at the time of data collection, when she was 62 years of age. Her speech was compared to that of her twin sister, who had remained in their country of birth, the Netherlands, and phonetic attrition was therefore measured in a perfectly controlled environment. The results revealed that MZ produced Dutch voiceless plosives with VOT values longer than the native Dutch norm of her twin sister, but not as long as the aspirated plosives of English, and that, overall, there was evidence for 'crosslinguistic assimilation patterns for all plosives, with voiced ones realized with a voicing lead in both languages, and voiceless ones with VOT values intermediate between short-lag and long-lag categories' (p. 693). In addition, MZ's monophthongs and diphthongs followed a general trend towards more open (higher F1) realisations compared with her twin sister's Dutch norm, which is in line with the expected more open pronunciation of English vowels (Mayr et al., 2012), with no dissimilation effects reported. Moreover, 'not only did L1 categories assimilate to L2 ones shift towards a more open position, but also L1 categories with no counterpart' (p. 696). Therefore, the authors suggest that cross-linguistic interactions operate at a system-wide level, rather than at the level of individual sounds, which is consistent with related research into early bilinguals (Guion, 2003) short-term phonetic drift effects (Chang, 2012; Guion, 2003), as well as with the notion of language specific phonetic settings (Mennen, Scobbie, de Leeuw, Schaeffler, & Schaeffler, 2010), i.e. the individual undergoing attrition does not only acquire individual sounds in the L2, but rather a particular articulatory setting, and this configuration impacts the L1 phonetic space generally, rather than token-by-token.

However, dissimilation effects, which have also been reported in phonetic attrition studies (de Leeuw et al., 2012; Evans & Iverson, 2007; Flege & Eefting, 1987), do not feed into this interpretation cleanly. If there is a system wide shift, there must also be scope for

phonetic attrition to occur at a level of individual sounds, as some individuals evidence dissimilation whilst others evidence assimilation *for the same sounds*.

18.7. Prosodic assimilation in phonetic attrition

In addition to segmental changes in the speech production of the L1 in sequential bilinguals undergoing attrition, it has also been shown that prosodic realisations are susceptible to attrition and can undergo assimilation effects. Mennen (2004) investigated native Dutch speakers who were at near-native level in their acquisition of L2 Greek. Although her sequential bilinguals did not live in Greece, they had all learned Greek as an L2 in adulthood; all had extensive experience with the L2 (between 12 and 35 years); all held a university degree in Modern Greek Language and Literature; were teaching Greek at university level in the Netherlands, and all used Greek regularly in their daily lives. As such, they were similar to subjects investigated in attrition studies, and the findings from her study are therefore of consequence to the questions of this chapter. Four out of five of her subjects were not only unable to realise Greek tonal alignment according to monolingual norms, they also showed a change in their native Dutch tonal alignment patterns. Specifically, the differentiation in the alignment of pitch peaks across Dutch long and short vowels was greatly reduced in their L1 speech. However, similar to the aforementioned interpersonal variation revealed (de Leeuw et al., 2010, 2012; de Leeuw, Mennen & Scobbie, 2013; Major, 1992) one of the bilinguals did produce tonal alignment with native-like values in both the L1 and L2, again suggesting that the extent of plasticity of native speech differs between individuals.

18.8. Segmental dissimilation in phonetic attrition

In addition to assimilation effects, research into the speech of late bilinguals has suggested that the late acquisition of an L2 can have dissimilation effects on the phonetic system of the L1. One study which explicitly reported dissimilation effects is that of Dutch native speakers who were highly proficient in English as an L2, which they had begun learning at 12 years of age in the Netherlands. These sequential bilinguals, who were between 20 and 35 years of age at the time of the experiment, and highly proficient in English, produced their Dutch /t/ with *shorter* VOT values than a group of Dutch L1 speakers who were less proficient in English (Flege & Eefting, 1987). Specifically, in the highly proficient subjects, the Dutch /t/ moved away from both the typical English value *and* the typical Dutch value (becoming shorter). Flege and Eefting (1987) suggest that this may have been a result of ensuring sufficient discrimination between the L1 and the L2 segments, but it is difficult to reconcile that these results are in contrast to the previously reported assimilation effects in VOT for the same language combination (Mayr et al., 2012). Perhaps, the earlier age of English acquisition in the Flege and Eefting study plays a role, although one would expect that in Mayr et al. (2012), MZ was similarly exposed to English at an early age in the Netherlands; alternatively, it may be that MZ was *even more* proficient in English than the Dutch-English highly proficient bilinguals in the Netherlands, with even higher proficiency evidenced through assimilation effects, and lower proficiency through dissimilation effects. Nonetheless, it seems plausible that an entirely system-wide explanation cannot account for these discrepant findings, as the competing systems are the same, but yield different results.

18.9. Prosodic dissimilation in phonetic attrition

Dissimilation effects have also been reported in an analysis of interpersonal variation of prosodic attrition in ten late German–English bilinguals (de Leeuw et al., 2012). In German,

both the start and end of the prenuclear rise occur later than in English (Atterer & Ladd, 2004), and it was therefore examined whether German native speakers who had moved to Canada in early adulthood would produce the prenuclear rise with an earlier alignment than the German monolingual matched control group. Although most of the bilinguals evidenced assimilation in their tonal alignment, it was also reported that two females out of ten native German speakers 'overshot' the monolingual German norm with respect to the tonal alignment of the pre-nuclear rise. In 'overshooting' the German monolingual norm, the alignment at the end of the rise occurred *even later* in their German productions than the already late German alignment, and was thus *more* dissimilar from both the German norm and the English norm (similar to the segmental dissimilation effects reported in Flege & Eefting, 1987). This finding was not highlighted in the research, potentially because dissimilation effects are so counter-intuitive when considering the consequences of two competing linguistic systems, and may even be interpreted as outlier effects in other studies (see e.g. high standard deviations in Flege, 1987 and Flege & Hillenbrand, 1984). However, dissimilation effects in some speakers, coupled with assimilation effects in others in this study (de Leeuw et al., 2012), again suggest that, at the very least, a system wide shift has a wide range of freedom, or, potentially, that competition from two language systems is also governed by both inter-speaker variation and token-by-token competition.

18.10. Global regional or foreign accent in a native language

In the present section, studies that have examined global regional or foreign accent in native speech are discussed. In a way, such research goes beyond the analyses of individual sounds and prosodic variables by investigating the perception of an individual's accent, and whether it is possible for someone to no longer be *perceived* to be a native speaker of his or her native

language, as in the previous acoustic investigations, it was not examined whether such fine phonetic differences from monolingual native speaker norms are actually *perceived* to be accented by listeners.

An early study into global regional accent perceptions in monolinguals reported that on average a group of Canadians from the province of Alberta, who had moved to Birmingham, Alabama, USA after 18 years of age, sounded more American-like than a comparable group of Canadians resident in Alberta (Munro et al., 1999). Some of the Canadians in Birmingham were judged to be just as American-sounding as actual American speakers, whilst others fell within the Canadian range. Although there was some indication that the amount of time spent in the US may have predicted inter-speaker variation in the bidialectal speakers, with Canadians living longer in Alabama having more American-accented speech, some speakers did not follow this pattern. Other predictor variables were not investigated in this study into global regional accent, but what is clear from the findings is that the native linguistic system was permeable within the domain of phonetics at a global level, which was perceivable by L1 listeners. Accordingly, this research largely corroborated the findings from Evans and Iverson (2007), as previously discussed; however, in the latter study, it is worth emphasising once more that one speaker dissimilated from the ambient variety, sounding more northern-like after two years in London than upon her arrival.

Building on this study in the context of bilingualism, de Leeuw et al. (2010) examined whether it was possible for native speech to become foreign accented upon acquisition of a new language in adulthood. Specifically, the objective was to determine whether native speakers of German living in either Canada or the Netherlands could be perceived to have a foreign accent in their native German speech. German monolingual listeners (n = 19) assessed global foreign accent of 34 L1 German speakers in Anglophone Canada, 23 L1 German speakers in the Dutch Netherlands, and five German monolinguals in Germany. The

bilinguals had moved to either Canada or the Netherlands at an average age of 27 and had resided in their country of choice for an average of 37 years. The findings revealed that the German listeners were more likely to perceive a global foreign accent in the German speech of the late bilinguals than in the monolinguals, and that, although 20 bilinguals were rated clearly to be native speakers of German, 14 bilinguals were rated clearly to be non-native speakers of German (although they *were* native speakers of German). Further analysis revealed that language use had a significant effect on predicting the extent of foreign accent in the L1, rather than e.g. age of arrival in their country of choice, or length of residence. Those bilinguals who were expected to code-switch more often were more likely to undergo phonetic attrition, i.e. be perceived as non-native speakers of their native German, than those who largely conversed in monolingual settings, where less code-switching was predicted, suggesting that monolingual modes (Grosjean, 1998) are likely to maintain phonetic properties of the L1 (de Leeuw et al., 2010).

A similar study, which investigated foreign accent in a group of 'L1 attriters', in comparison to a group of 'L2 acquirers', largely confirmed these findings (Hopp & Schmid, 2013). A main goal of this study was to determine whether a group of German native speakers who had moved from Germany to Canada or the Netherlands after age 17, and had used their L2 most frequently in daily life after having lived abroad for more than 15 years, were rated to be less native-like in a global foreign accent rating (as in de Leeuw et al., 2010), than a group of late L1 English and L1 Dutch L2 acquirers of German. At the group level, the findings revealed that the 'L1 attriters' did not differ from the monolingual German speakers. However, of the 40 'L1 attriters', 29 scored within the range of the native controls, whereas 11 scored outside this native range. The authors interpreted their findings to show 'that acquiring a language from birth is not sufficient to guarantee native-like pronunciation, and late acquisition does not necessarily prevent it' (p. 361). However, in exploring why some

individuals were more likely to undergo phonetic attrition than others, the results were inconclusive: no independent variable significantly predicted the extent of phonetic attrition, which contrasted with the findings from de Leeuw et al. (2010).

Finally, in a more recent study, it was investigated whether foreign accent ratings would be associated with acoustic measurements of vowels and consonants, i.e. whether those late bilinguals who were categorised as phonetic 'attriters' in a foreign accent rating task would likewise exhibit phonetic measurements which deviate from the monolingual group (Bergmann et al., 2016). The study examined 33 L1 speakers of German, residing in the USA or Canada, where they made use of their L2. Results from the ratings showed that native-likeness was negatively associated with length of residence abroad and positively associated with L1 use. Second, formant analyses of four speech sounds in German—/aː/, /ɛ/, /ɔ/ and /l/—showed that most acoustic differences were observed in /aː/ and /l/ whilst the other formant frequency values were not significantly different from the monolingual group. However, it was not the case that a stronger foreign accent in the late German-English bilinguals was associated with more deviant formant frequency values in these sounds, therefore suggesting that other segmental, or more likely prosodic features, were responsible for the foreign accent ratings.

18.11. Summary of research

The studies discussed in this chapter revealed a common finding that the phonetic system of the L1 is malleable upon competition from a new language or dialect in adulthood. Although inter-subject variability with regard to the extent of phonetic attrition was evidenced, in their entirety, the findings indicate continued plasticity in native speech throughout the entire

lifespan. Examining the studies together, the following 10 key findings, in no order of importance, can be presented.

1. Research which reports phonetic attrition, as described in this chapter, combined with changes to the L1 phonetic system due to dialects changing over time (Harrington, 2006; Harrington et al., 2000a, 2000b), style-shifting (Bell, 1984; Coupland, 2007; Eckert & Rickford, 2001), and short-term rapid changes to the L1 phonetic system upon L2 training and exposure (Chang, 2012; Sancier & Fowler, 1997), lend support to the understanding that there is plasticity in native speech beyond adolescence.
2. Although phonetic attrition is consistently observed in analyses of speakers who have an increased dominance in their new dialect or language, there is interpersonal variation in the extent of phonetic attrition, and some research suggests that increased L1 use in a monolingual mode maintains native speech pronunciation (de Leeuw et al., 2010; de Leeuw et al., in press; Bergmann et al., 2016).
3. Assimilation effects between L1 and L2 sounds have been evidenced in the VOT of plosives in phonetic attrition (Flege, 1987; Flege & Hillenbrand, 1984; Mayr et al., 2012), although dissimilation effects in the VOT of plosives in the L1 have also been reported in advanced L2 learners (Flege & Eefting, 1987). This discrepancy suggests that phonetic attrition incorporates both systematic merging (Chang, 2012; Guion, 2003; Mayr et al., 2012), as well as token-by-token level changes (de Leeuw, Mennen, & Scobbie, 2013; Flege, 1987; 1995; 2007; Ulbrich & Ordin, 2014).
4. Assimilation effects between L1 and L2 sounds have been reported through formant frequency analyses of vowels and liquids (Bergmann et al., 2016; de Leeuw, Mennen, & Scobbie, 2013; de Leeuw et al., in press; Evans & Iverson, 2007; Flege & Hillenbrand, 1984; Mayr et al., 2012; Ulbrich & Ordin, 2014), although further research is necessary to examine the precise form which intermediate tokens might

take (e.g. whether the 'merging' becomes entirely L2-like, or whether one acoustic variable, i.e. F1 frequency, becomes more L2-like, whilst another acoustic variable, i.e. F2 frequency, remains L1-like, (de Leeuw, Mennen, & Scobbie, 2013).

5. Assimilation effects have been reported in prosodic analyses of L1 speech (de Leeuw et al., 2012; Mennen, 2004) and are suggested in global foreign accent effects (de Leeuw et al., 2010; Hopp & Schmid, 2013), but note that dissimilation effects have also been reported in prosody (de Leeuw et al., 2012) and in global regional accent ratings (Evans & Iverson, 2007).
6. Assimilation processes can involve intermediate 'merging' between the L1 and L2 categories (Flege, 1987), and in the case of 'extreme phonetic attrition' the realisation of the L1 phoneme can occur entirely in the space of the L2 phoneme (de Leeuw et al., in press).
7. Informal speech is more likely to evidence phonetic attrition (Major, 1992; Shockey, 1984), i.e. if speech is elicited formally, the effects of phonetic attrition might not be evidenced at all.
8. Careful speech with a high information content appears to be less likely to elicit phonetic attrition (Shockey, 1984).
9. In the case of more than one standard variety of the L2, the ambient language might not drive phonetic attrition, but rather 'actual creative language use and communicative events' could influence processes of phonetic attrition (Ulbrich & Ordin, 2014, p. 26), potentially suggesting that a non-ambient target variety may induce phonetic attrition.
10. Phonetic attrition, as it occurs in the context of new dialect (Evans & Iverson, 2007; Munro et al., 1999; Shockey, 1984) or new language (Bergmann et al., 2016; de Leeuw, 2014; de Leeuw et al., 2010, 2012; de Leeuw, Mennen, & Scobbie, 2013;

Flege & Hillenbrand, 1984; Flege, 1987; Hopp & Schmid, 2013; Major, 1992; Mayr et al., 2012; Mennen, 2004; Ulbrich & Ordin, 2014) acquisition, has been reported at both the segmental and prosodic level of native speech, as well as in overall changes to an individual's native accent.

18.12. Discussion of implications of phonetic attrition

If, as this chapter suggests, the phonetic system is *more* vulnerable than other linguistic domains, such as that of morphosyntax (see Köpke & Schmid, 2004, who suggest that linguistic domains are differently affected by attrition), it is plausible that that from which all other language representations are built are destabilised as well, once phonetic attrition occurs. Phonetic attrition would thus reflect the start of an unbalancing of the native language system, which arises from the perception of phones, before distinctive phonemes, lexemes, and syntactic structure (e.g. Maye et al., 2002; Polka & Werker, 1994; Stager & Werker, 1997; Werker & Lalonde, 1988). Therefore, relevant future research questions might relate to, for example, how phonetic changes in the L1 potentially trickle down into other linguistic domains. Further questions of relevance relate to how regulation of the L1 and L2 phonetic systems impacts cognition more generally (de Leeuw & Bogulski, 2016), as well as to how the regulation of the L1 and L2 phonetic systems change over time, in different contexts in longitudinal analyses as studied through a segmental and prosodic analysis of the native German speech of Stefanie Graf over four decades (de Leeuw, submitted). Questions might also focus on comparing different groups (e.g. those with brief exposure to the new language, versus those with long-term exposure), to determine whether interactional effects differ, and the extent to which accommodation effects resemble phonetic attrition.

A final interpretation emerging from this article, but certainly not unique to it, is that the languages of a bilingual, and indeed the dialects of a monolingual, are separate linguistic systems, but not fully autonomous from one another (Baker & Trofimovich, 2005; Caramazza, Yeni-Komshian, Zurif, & Carbone, 1973; de Leeuw, 2014; Fowler, Sramko, Ostry, Rowland, & Hallé, 2008; Grosjean, 1998; Hopp & Schmid, 2013; Mayr, Morris, Mennen, & Williams, 2015; Paradis, 2001; Sundara, Polka, & Baum, 2006). As such, phonetic attrition, as a symptom of increased cognitive load in bilinguals over monolinguals (de Leeuw, 2014), is simply one case in which the languages of a bilingual, or indeed the dialects of a monolingual, interact. This interaction between the competing linguistic systems differentiates those with competencies in more than one linguistic system from those who possess only one linguistic system, should such individuals exist at all (Cook, 1992; de Leeuw, 2014; Grosjean, 1998; Hopp & Schmid, 2013; Rothman & Treffers-Daller, 2014). Future research into phonetic attrition will surely tell us more about the plasticity of native speech and cognition more generally.

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